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THE  
*Planetary Instrument.*

OR THE

**Description and Use of the Theories of the Planets :** drawn in true Proportion, either in one, or two Plates, of eight Inches Diameter ; by *Walter Hayes*, at the *Cross-Daggers* in *Moor-Fields*.

Being excellent Schemes to help the Conceptions of Young *Astronomers* ; and ready Instruments for finding the *Distances, Longitudes, Latitudes, Aspects, Directions, Stations, and Retrogradations* of the *Planets* ; either *Mechanically, or Arithmetically* ; with Ease and Speed.

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By *Mr. John Palmer*, Rector of *Eaton*, and Arch-Deacon of *Northampton*.

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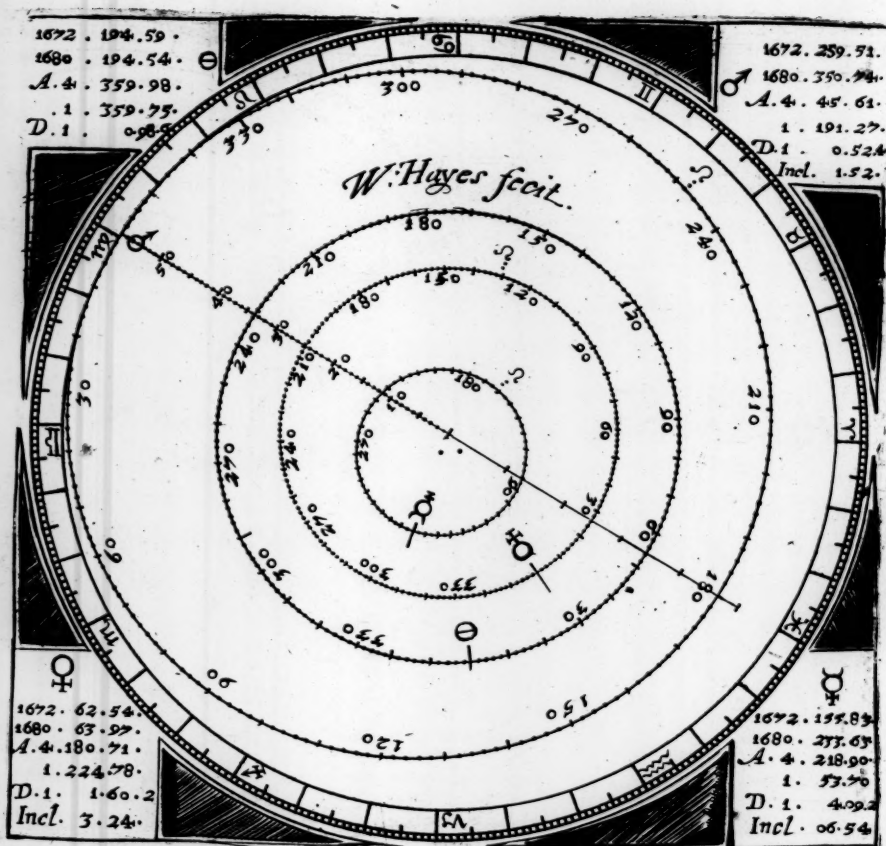
The DESCRIPTION.

**T**HE first Plate (which I call *Saturn's Plate*) contains the *Theories* of  $\text{♄}$   $\text{♅}$   $\text{♆}$   $\text{♁}$  : also short, but sufficient Tables of their *Anomalies* ; and a Scale for measuring their Distances in *Semi-diameters* of the Earth.

The second Plate (which I call *Mars's Plate*) contains the *Theories* of  $\text{♂}$   $\text{♁}$   $\text{♀}$   $\text{♃}$ , with like Tables of their *Anomalies*, and Scale of Distances.

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The *Sun* is in the Center of the *Plate*. The other Planets have their several *Eccentrics* & *Orbits*. These should be *Ellipses*, but *Circles* will serve sufficiently, especially for *Instruments*. Mr. *S. Foster* disposed these *Planets* in four Plates, and added thereto other Devices, to be seen in a Book published since his Death. Here they are all contrived in two Plates, or two sides of one Plate: and whereas Mr. *F.* supposed the *Apheliums* and *Nodes* moveable, in these *Theories* they are fixed, according to Mr. *Street's Hypothesis*: by which means, though they be framed to the end of 1680, yet not only for this Age, but (with allowance of the Procession of the *Aequinoctial*) they may serve perpetually.

The *Aphelium* of a *Planet* is the point of his *Eccentric*, which is furthest from the *Sun*, and from *Aphelium* is the *Anomaly* counted.

The *Anomaly* is the circular Distance of a *Planet* from his *Aphelium*. But though the *Anomalies* be equal, yet their Divisions in every *Eccentric* are unequal, because they are made to contain the *Aggregates* of the *Anomalies*, and *Prosthaphoreses* of the *Orb* compounded together.

Where you see two or three pricks on one side the *Orbit*, and  $\oslash$  on the other side, there the *Planet* goes into *North Latitude*, and at the opposite Point over the Center, is the Place of  $\oslash$ , where he goes into *South Latitude*.

### The Use of the *THEORIES*.

This shall be shewn in three *Examples* only, which may suffice.

But, *Note 1.* That I begin the Years and Days 24 hours later than Mr. *Street*; for I count the last day of *December* to end in the *Noon* of the *Circumcision*; which is the old way: and to that Account these *Theories* and *Tables* are fitted: and all Years and Days here are counted Compleat.

*Note 2.* That in gathering the *Anomalies* out of the *Tables*

*Tables*, if the same exceed a *Circle*, (or  $360^\circ$ ) you must by *Subtraction*, or *Division*, cast away all whole *Circles*, take the *Remainder* for the *Anomaly* sought. The Numbers in the *Tables* are *Degrees*, and *Centesimal* parts, and for the *Diurnal Motion*, another *Figure* is added, to make the *Parts Millesimal*. In the *Tables*, A. stands for *Anni*, that is, *Years*: D. stands for *Days*: Incl. stands for *Inclination*; which is set down in *Degrees* and *Minutes*,

EXAMPLE. I.

1675. April 1. I saw *Mars* above the foremost foot of *Apollo*, and he seemed to be much diminished in Magnitude.

First out of the Table for  $\ominus$ .

write out for 1672 194. 59.  
for two Years more  $\left\{ \begin{array}{l} 359. 75. \\ 359. 75. \end{array} \right.$

for 90 days the product

of 986 by 90 is — 88. 74.

1002. 83.

for 2 *Circles* deduct 720.

For  $\delta$ .

259. 51.

$\left\{ \begin{array}{l} 191. 27. \\ 191. 27. \end{array} \right.$

524 in 90 — 47. 16.

689. 21.

deduct 360.

*Anomaly* of  $\ominus$  — 282. 83. *Anomaly* of  $\delta$  329. 21.

Now in the *Earths Orbit*, at 283, make a prick with Ink for  $\ominus$ ; for there is  $\ominus$  for this time: and likewise prick  $\delta$  in his *Orbit* at 329.

Lay a *Ruler* from the Place of  $\ominus$  over the  $\odot$  (in the *Center*) and it shall cut in the *Limb*  $\gamma$   $21^\circ 38'$ , the  $\odot$ 's *Longitude*. Again, lay a *Ruler* from  $\ominus$  to  $\delta$  (I mean, the pricks set for them) and know, that a *Line* Parallel to your *Ruler*, passing through the  $\odot$  (or *Center*) will cut in the *Limb* the *Longitude* of  $\delta$ .

Take therefore with your *Compasses* the nearest distance of the *Center* from the *Ruler*, and let one foot slide along the *Ruler* from  $\ominus$  to  $\delta$ , and beyond him; and let the other

A 2

foot

foot, keeping even pace with his fellows, pass from the *Center* to the *Limb*, and so it shall touch in the *Limb*  $\Pi$  29 $\frac{1}{2}$ , the *Longitude* of  $\delta$ .

Another way. Mark well the *Triangle* made by your two *Pricks* and the *Center*, that is, by  $\oplus \delta$  &  $\odot$ . Measure the sides upon your *Scale*, and you shall find— $\odot \oplus$ —3500

Now if you have 2 *Thrids* from the  $\odot \delta$ —5700 } *Semid.*  
*Center*, and lay one upon  $\oplus$ , and the  $\oplus \delta$ —6000 } of  $\oplus$   
 other upon  $\delta$ , the *Arch* of the *Limb*

between them, is the Measure of the *Angle* at the  $\odot$ , (or of *Commutation*) and is here  $77^{\circ} 42'$ . With this *Angle* and the *Sides* comprehending it (which are 35 and 57, as before) you may by *Pitiscus* his third *Axiome*, Calculate the other *Angles*, and find *Ang.* at  $\oplus$  (or *Elongation*)  $67^{\circ} 41'$ , and *Ang.* at  $\delta$  (or *Paralloxis Orbis*)  $34^{\circ} 37'$ . The *Elongation* of  $\delta$  ( $67^{\circ} 41'$ ) added to the *Long.* of  $\odot$  ( $\text{r}21^{\circ} 38'$ ) makes the *Long.* of  $\delta$ , 89.17. that is  $\Pi$  29.17.

Another way. Transfer your *Triangle* upon Paper, and there, by help of a *Scale* of *Chords*, or a small *Quadrant*, and *Compass*, you may easily find all the *Angles* very near the truth; *Viz.* *Ang.* ad  $\odot$   $77^{\circ} 42'$ . *Ang.* ad  $\oplus$   $67^{\circ} 54'$ . *Ang.* ad  $\delta$   $34^{\circ} 24'$ .

Note, That the reason of  $\delta$  his Diminution is the Increase of his Distance from the *Earth*; for you may measure it upon the *Plate* 6000: but in his  $\delta$  he may be distant but 1320, and never above 2350.

For the *Latitude* of  $\delta$ , lay one *Thrid* from the *Center* to  $\odot$ , and another *Thrid* to  $\delta$ , the *Arch* of the *Limb* intercepted by the *Thrids* (76. 10.) is *Argumentum Latitudinis*.

Now as the *Radius* to the *Tang.* of  $1.52'$ , the *Inclination* of  $\delta$ : So is the *Sine* of 76.10' to the *Tang.* of  $1.49'$ ; the *North Latitude* of  $\delta$  seen at the *Sun*.

And as  $\oplus \delta$  to  $\odot \delta$ ; so is the *Tang.* of the *Lar.* at the *Sun*, to 1.44'; the *Tang.* of *Lar.* seen at the *Earth*.

#### EXAMPLE II.

1677. Octob. 28. (being St. Simon and Jude's) at Noon,  
 I seek  $\gamma$  Place. 1672



	☉	♄
1672. ———	194.59	155.83
A. 4. (or 4 Years)	359.98	218.90
Days 300 ———	295.80	147.60
	8	
	850.37	522.33
Subtract the Circles — 720.		360.
	130.37	162.33
Anom. of ☉	130.37	Anom. of ♄

Prick the ☉ and ♄ in their *Orbits*, at the end of these *Anomalies*, and you shall see the Prick for ♄ fall in the very *Node* at ♄; and laying a *Thrid*, or *Ruler* from the *Center* to ♄ or ☉, it shall cut them both, and shew that ♄ is in a *Corporal Conjunction* with ☉. This ☉ ♄ would be observed: for by the help of fit *Glasses*, ♄ may be seen in the ☉ for several hours; and according to the best *Tables*, he shall pass within 4 or 5 minutes of the ☉'s *Center* in *North Lat.* EXAMPLE III.

1673. May 25. In the day time I saw ♄ with a *Telescope*, horned like the ♄ at 3 or 4 days old; and though she was so much *waned*, she appeared bigger and brighter than at any time since she came last out of the *Sun-beams*.

	☉	♄
1672. 194. 59		62. 54
144 days. 141. 98		230. 69
Anom. ☉ 336. 57		293. 23 Anom. ♄

Prick these *Planets* in their *Anomalies*, as before was taught. Lay a *Ruler* from ☉ over the *Center*, and it shall cut in the *Limb* the *Long.* of the ☉,  $\Pi$  14. 11'. The *Ruler* thus lying, draw a *Thrid* from the *Center* over ♄. Now between the *Ruler* and the *Thrid* is the *Angle of Commutation* ( $163^\circ$ ) and there adjoyneth to it the *Supplement* thereof ( $17^\circ$ ) which in your *Triangle* is *Angulus ad ☉*, and is measured by the *Limb*.

Lay your *Ruler* from ☉ to ♄, and the *Parallel Line* made,  
or

or imagined to be made, with your *Compasses* through the *Center*, will cut  $\odot$   $17^{\circ}$ ; the *Long.* of  $\odot$ , and the *Arch* between this and the  $\odot$ 's Place before found, is the *Elongation* of  $\odot$  from  $\odot$  *Eastwards*,  $32.49'$ . And the *Summe* of the *Commutation* and *Elongation* taken out of 180, leaves the *Angle* at  $\odot$   $130.11'$ .

Another way. In the *Triangle*  $\odot \odot \odot$ , you may take all the sides in your *Compasses*, and measure them upon the *Scale*, that is,  $\odot \odot$  3520.  $\odot \odot$  2450. and  $\odot \odot$  1370. Then either by *Protraction* find the *Angles*: or, the *Angle* of *Commutation* being known ( $17^{\circ}$ ) and the sides including by *Ax.* 3. *Pitisci*, you may compute the *Angle* at the  $\odot$   $32.49'$  and the *Angle* at  $\odot$   $130.11'$ .

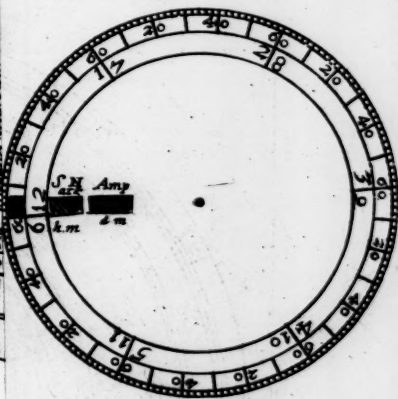
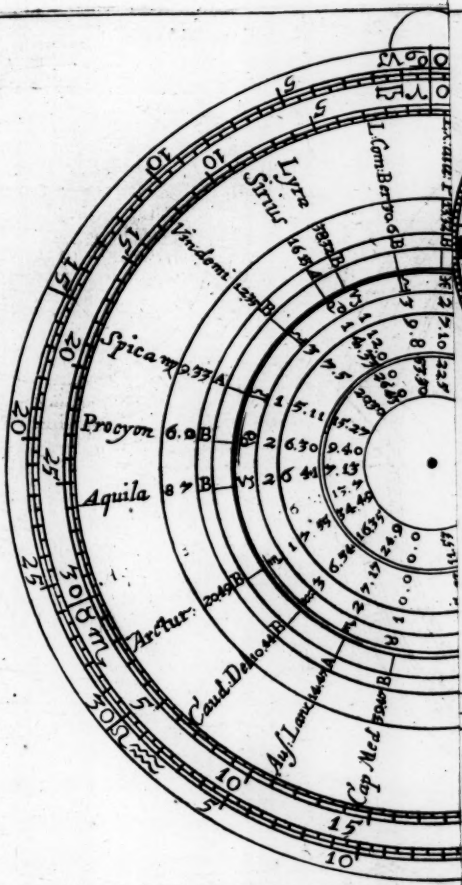
This *Angle* at  $\odot$  measureth her *Waxing* and *Waning*.

Let the *Radius* be 100, the *Diameter* of  $\odot$  200, the *Angle* being  $130.11'$ , the versed *Sine* thereof ( $165$ ) measureth the dark part of the *Diameter*; the residue ( $35$ ) is light: So  $\odot$  is *Waxed*  $\frac{35}{200}$  of her *Diameter*; that is almost 10 *Digits*; and yet she seems much bigger than when she was *Full*: because 2 *Digits* of light in her present *Distance* (of 1370) contain more *Seconds* of light than her full *Disk* could contain; when coming from the  $\odot$ , she was distant about 6000, as you may measure upon the *Plate*.

How these *Plates* may be also useful for Observing *Altitudes*, *Azimuths*, *Declinations*, and *Inclinations* of *Plains*, &c. They who have any Skill in the *Mathematicks*, may easily discern without further *Admonition*.

FINIS.





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This *Angle* at  $\ominus$  measureth her *Waxing* and *Waning*.

Let the *Radius* be  $100$ , the *Diameter* of  $\ominus$   $200$ , the *Angle* being  $130.11'$ , the versed *Sine* thereof ( $165$ ) measureth the dark part of the *Diameter*; the residue ( $35$ ) is light: So  $\ominus$  is *Waned*  $\frac{165}{200}$  of her *Diameter*; that is almost  $10$  *Digits*; and yet she seems much bigger than when she was *Full*: because  $2$  *Digits* of light in her present *Distance* (of  $1370$ ) contain more *Seconds* of light than her full *Disk* could contain; when coming from the  $\odot$ , she was distant about  $6000$ , as you may measure upon the *Plate*.

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